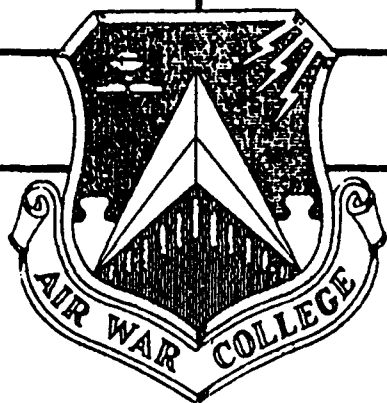


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AIRCRAFT REGENERATION--A KEY FORCE STRUCTURE CONCEPT

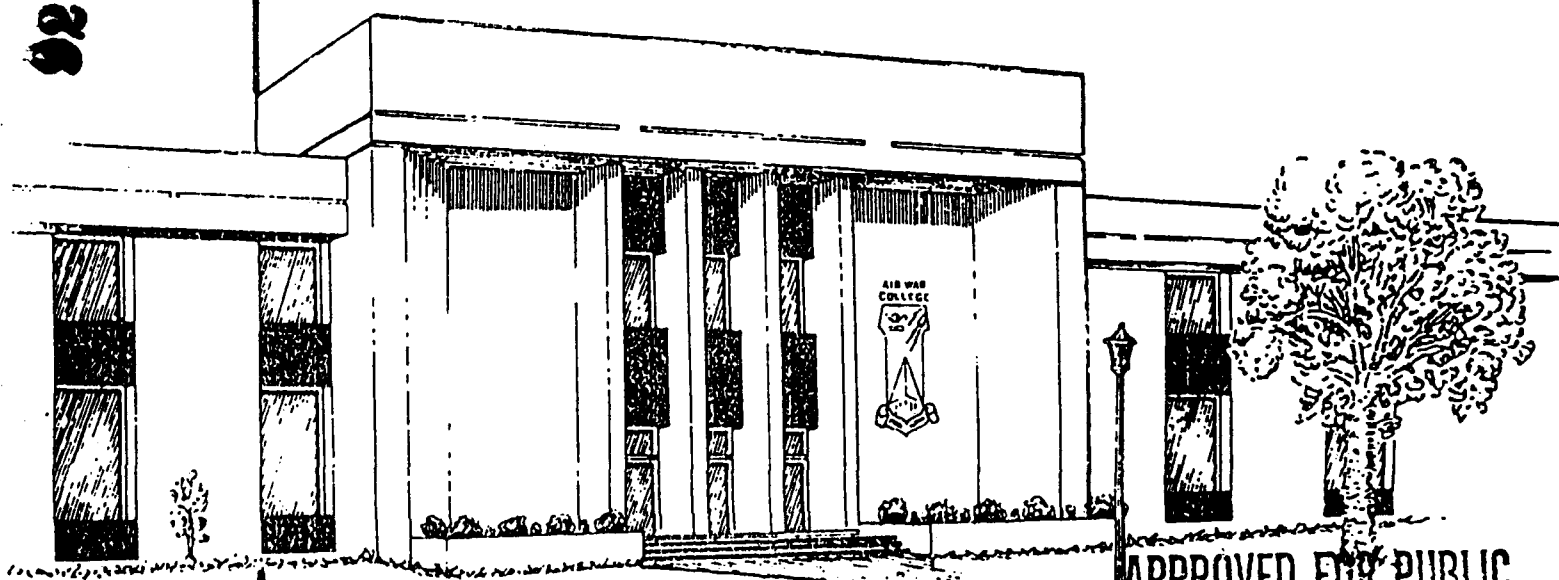
FOR TRANSITION INTO THE TWENTY-FIRST CENTURY

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LIEUTENANT COLONEL THOMAS M. CRAWFORD III

1991



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Aircraft Regeneration: A Key Force Structure Concept  
for Transition into the Twenty-First Century

by

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

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# Aircraft Regeneration: A Key Force Structure Concept for Transition into the Twenty-First Century

## Overview

"The most fundamental guideline for equipping the United States Air Force is that the unique flexibility of airpower must be preserved so that it can be exploited when required."<sup>1</sup>

The end of the Cold War, perceived "peace dividends," and the realities of a declining military budget have created a situation that has been encountered previously only at the end of major conflicts such as World War I, World War II, Korean War and Viet Nam War. This situation is a possible excess of mission-capable aircraft. In the past we have retired, sold, and destroyed most of our excess forces. The process of developing and procuring new weapon systems is lengthy and costly. Therefore, we need to change the way that we manage our aircraft inventory. Although I will concentrate on the concept of aircraft regeneration<sup>2</sup>, the principles of regeneration apply to space systems, support equipment, vehicles, material handling equipment, missiles, and communications-electronics systems.

## AMARC Mission, Accomplishments, and Capabilities

In 1985 the Military Aircraft Storage and Disposition Center was renamed the Aerospace Maintenance and Regeneration Center (AMARC). The change reflected a mission shifting toward emphasis on regeneration of aircraft. The AMARC facility at Davis-Monthan AFB, Arizona, is ideally suited for

long-term storage and regeneration efforts. The dry desert environment is the most ideal location for storage of aircraft. In addition, over many decades of storing and regenerating aircraft AMARC has developed techniques for long-term protection; salvaging and reclaiming key components; periodic inspections; and making aircraft airworthy again. An extensive Desert Storage Test Program was conducted from 1972 through 1974, concentrating on the best long-term aircraft preservation processes. The results of the test program were incorporated into the AMARC procedures.<sup>3</sup> During fiscal year 1990 AMARC regenerated 202 airframes for use as mission aircraft, drones, and museum display.<sup>4</sup>

#### Budget and Force Structure Implications

The current Five Year Defense Plan has identified significant cuts in our military budget that can be accomplished only by force reductions, cancelling or stretching out purchases of new weapon systems, or a combination of cuts and cancellations. Senator Sam Nunn's proposal for a new military strategy includes "improving existing platforms and reducing new starts; innovative research to preserve our technological superiority; and preserving a viable defense industrial base."<sup>5</sup> Senator Nunn also believes strongly in emphasizing product improvements whenever those decisions are "smart."<sup>6</sup>

The Packard Commission emphasized product improvements to existing weapon systems as an alternative to designing new generations of weapons. Despite this recommendation, the pending budget request continues most of the major new weapon development programs while terminating existing weapons, some of which could be updated at far

less expense. 7

I believe that in the next few years our Air Force will be forced to shrink drastically in size. The estimate of defense budget cuts through the next five years ranges from administration figures of 2-25 percent to as much as 50 percent.<sup>8</sup> In an era of declining budgets, we are forced to make a tough decision between maintaining our current force structures or developing and procuring new weapon systems.

Addressing the salutary results of systems-upgrade programs, General Welch declared that, in using that approach, 'we've doubled the capability of the B-52. We've increased the capability of each tanker by fifty percent. We've transformed the F-16 from a day fighter into a highly effective multimission aircraft. We have continued to grow the air-superiority capability of the F-15, which is eleven years old. The approach works. It's cost-effective. But when our capability to meet the threat can't be satisfied [by] using that approach, we have no choice but to step up to the kinds of investments that it takes to exploit technology and produce new systems.'<sup>9</sup>

Therefore, the most logical answer is to remove some of our older weapon systems, while maintaining research, development, and procurement of new weapon systems. With a mix of existing aircraft and new weapon systems we can maintain superior capability and technical superiority, and still protect our vital procurement, research, and development.

#### Options

The Air Force has three options that it can use when it takes an aircraft out of the inventory. First, if it has no remaining service life or usefulness (after reclaiming designated components and engines) it can be sold for salvage. Second, it can be sold or given away (primarily to a third

world country as a part of the security assistance program). Or third, it can be regenerated and possibly flown again. As a regenerated aircraft, the air vehicle may evolve into a drone, reenter the inventory as an operational weapon system, or become a museum display.

At the end of World War II, the United States sold over 35,000 aircraft (primarily trainers and transports), and made plans to scrap or store the remaining 30,000 aircraft at the newly designated central storage facility at Davis-Monthan. The requirements of the Berlin Airlift and Korea caused thousands of these stored or scrap-designated aircraft to be regenerated.<sup>10</sup> The history of Davis-Monthan shows extensive regeneration of aircraft over the past four decades, especially in response to conflicts such as the Berlin Airlift, Korean War, Cuban Missile Crisis, and Viet Nam War.<sup>11</sup> A classic example was the operational deployment of the AC-47 gunship in Viet Nam while its replacement, the AC-130 gunship, was being developed. "In this case, a relatively evolutionary weapon used new technology to improve on older systems and tactics."<sup>12</sup>

Keeping aircraft in the inventory for thirty years or more is becoming the rule rather than the exception. Such workhorses as the F-4, B-52, KC-135, C-130, C-141, and F-15 are stable design types that will carry the load for many years to come. Despite their ages, each of these aircraft has been and continues to be a significant part of this country's powerful arsenal because of their ability to accept modifications.<sup>13</sup>

#### Storage Proposal

But why retire aircraft that still have a significant service life? I propose that the Air Force establish a pro-

gram to store a large portion of our aircraft inventory (25-50 percent) with the intention of regenerating them in the future. This plan should have significant benefits and minimal risks. In fact, it can be considered as an insurance policy for weapon-system capabilities.

The procurement of new weapon systems is rife with potential problems. Examples are contractors who are unable to meet production and delivery schedules, cost overruns, reduced congressional funding or unprogrammed stretchouts of procurement, changes in the threat or operating environment, and inability of the contractor to meet minimum specifications or overcome technical complications. Any of these conditions could cause disastrous shortfalls in the military capability of our Air Force, but a regenerated aircraft could serve as both a transition and an insurance policy against such pitfalls.

Storing aircraft has an immediate, positive impact on our budget process and supportability of remaining aircraft. It reduces operating and maintenance expenses because stored aircraft need not be flown. In addition, key components such as avionics and engines can be removed from the aircraft and put back into supply channels. Such practices would reduce requirements for purchasing some spare parts and increase mission availability and supply levels for the remaining fleet. As an example, the recent reengining of 185 KC-135E aircraft with commercially salvaged engines resulted in an estimated savings to the Air Force of \$750 million.<sup>14</sup>

### Storage Operation

The storage and regeneration process for our fleet would be a key part of a weapon-system master plan. The basic concept would be to store aircraft that still have a significant remaining service life while continuing to fly our top-of-the-line aircraft and those effective aircraft that have a limited remaining service life. Ideally, the aircraft targeted for storage and future regeneration should have about half of their service life remaining. Aircraft approaching the end of their service life are not as cost effective to regenerate, their regeneration requirements can be extensive, and their limited remaining service life after regeneration limits their contributions. Aircraft with a great deal of remaining service life are also probably not the best candidates. These newer aircraft can not take advantage of as many technological improvements and storing them would deprive the Air Force of a capable fighting force. The decision as to which aircraft are to be restored and regenerated, which must begin with the Air Force Logistics Command (AFLC) System Program Manager (SPM), would depend on a variety of issues such as remaining service life, mission requirements, and security threats.

In many cases we need to validate the service life and limitations of our fleet. "Hundreds of C-135 aircraft, the first of which was delivered in 1955 with a projected service life of 10,000 flying hours, are still going strong and are headed toward 36,000 hours."<sup>15</sup> In addition, mission-profile



changes (e.g., high-altitude to low-altitude for B-52s) can cause a considerable impact on the service life and logistics supportability of weapon systems.

#### Advantages of Regeneration

The most important benefit of regeneration is that it can take advantage of technological improvements. "In the past, the United States led (the Soviet Union) in 15 of 20 key technology areas, with the United States and the Soviet Union about equal in the remaining 5. Recent trends, however, are not as good."<sup>16</sup> In addition, many of our technological advantages in aircraft can disappear almost overnight. This can occur through commercial purchases, reverse engineering, and technology improvements in the threat. This "perishable" technology can be improved or replaced on aircraft as a part of the regeneration process so that the regenerated aircraft have the best capabilities available. Before a stored aircraft is regenerated, it may utilize technological enhancements. Regeneration will also provide a greatly increased capability while decreasing costs, providing improved availability, creating attrition fillers for existing aircraft, simplifying transition into new weapon systems, providing a force more responsive to the threat, providing test vehicles for further improvements, and maximizing the advantages derived from new weapon systems.

#### Technology Improvements

Avionics is a key area where in state-of-the-art technology has been inserted into existing aircraft. For ex-

ample, monolithic microwave integrated circuits (MMICs) are being used on solid-state array airborne radar and in electronic-warfare applications at one-tenth the cost and in one-third the space, with improved capabilities, and 25 times more functional reliability than previous circuits.<sup>17</sup> Regenerated aircraft could take advantage of this new technology as they are reintroduced into the inventory.

The F-111D digital signal transfer unit was originally manufactured with two complex circuit boards that each cost \$24,000 and had a mean time between failure of forty hours. By replacing these two boards with one very-high-speed integrated circuit (VHSIC) board, the cost has decreased to \$3,000 for a single board and reliability has improved over ten thousand percent to an average of 5,000 hours between failures.<sup>18</sup> The remarkable advantages of VHSIC have revolutionized the electronics industry and demonstrated significant savings in weight, power requirements, size, and cooling requirements. VHSIC also can yield improved sustainability, redundancy, lower life cycle costs, configuration simplification, improved reliability and maintainability. Most importantly, VHSIC has increased capability and availability.

The technologies currently being developed for future aircraft could yield exceptional capabilities for regenerated aircraft. Specifically, improvements in turbopropulsion capability and the hydrocarbon fuel developments in hypersonic propulsion may render many of our current propulsion systems

obsolete.<sup>19</sup> When these technologies are applied to existing weapons systems, we may have a substantial increase in capabilities.

The regeneration process could be a costly option that might force us to decide between regeneration and procuring new weapon systems. The keys to avoid the disadvantages of regeneration are proper planning and a commitment to the overall regeneration process. It will take visionary leaders and a realistic commitment to regeneration to make the principle happen.

Regenerated aircraft have often been used by the Air Force as remotely piloted vehicles (RPV) for target drones. In addition, RPVs "can already substitute very advantageously for piloted aircraft used in reconnaissance, and they could easily be developed to serve as strike aircraft as well."<sup>20</sup>

Computers have greatly enhanced the combat capability of our front-line combat aircraft. The rapid and impressive advances in artificial intelligence may yield significant benefits in our ability to successfully identify, engage, and destroy enemy ground and airborne resources. Artificial intelligence may provide expert systems diagnostics that will reduce reaction time, provide recommended aircrew responses, and improve maintenance actions. Regenerated aircraft could incorporate these computer technology advances and artificial intelligence.

Over the last twenty years, microelectronics have doubled the storage capability of dynamic random access

memories every 2.5 to 3 years. "Other important benefits achieved with shrinking size include lower power demand, higher reliability, lower cost and very high speed."<sup>21</sup> Microelectronics is just one of twenty critical technologies that the Secretary of Defense and Secretary of Energy have planned to develop in order to ensure "the long-term qualitative superiority of United States weapon systems"<sup>22</sup> The major long term goals of these twenty technologies are improved deterrence, military superiority and affordability. These critical technologies could greatly enhance regenerated aircraft.

In 1985 the United States Air Force completed a comprehensive study (PROJECT FORECAST II) to "identify the high-leverage technologies that would contribute to significant improvements in the Air Force's warfighting capabilities in the next 10 to 20 years".<sup>23</sup> The 39 Project Technologies and 31 Project Systems selected during the PROJECT FORECAST II evaluation may have the most potential for use in any regeneration efforts.

#### Spares

When an aircraft is stored for possible future regeneration, the AFLC Item Manager (IM) and SPM determine which components must be removed and entered into the Air Force supply inventory in order to support the remaining aircraft. This "save" list is a critical part of the logistics support process for the entire weapon system. Any components that are in immediate need due to shortages in the War Readiness

Spares Kits (WRSK) and Base Level Sufficiency Stocks (BLSS) are prime candidates. In addition, items that are technologically fragile or impossible to preserve during the storage process should be "saved." The replenishment of these removed components with replacements and improved components is a key element of the regeneration plan. In fact, the IM should evaluate the regeneration process, use developing programs and technologies whenever possible, and advocate the development of improved items wherever there is a benefit. This process should also reduce parts counts and aid in simplifying the repair and procurement process.

During FY90 the "save" list of spares resulted in over 275,000 components generated from AMARC into supply channels at a savings of \$351.5 million.<sup>24</sup>

The recycling of spare parts during storage of regeneration aircraft may cause many aircraft parts suppliers to lose potential contracts and may jeopardize their futures as suppliers of military parts. Close coordination with parts suppliers must be accomplished to ensure that our industrial base is capable of responding to future requirements.

#### Cost Savings

Lieutenant General Viccellio (AF/LE) believes that "our challenge for the nineties is to sustain the improvements in capability achieved during the eighties, but to do so at a reduced cost."<sup>25</sup>

Regeneration provides significant cost savings. Approximately 25 percent of the Air Force annual budget is

allocated directly to operations and maintenance expenses.<sup>26</sup> Storage of aircraft would provide a substantial reduction in these expenses. Regeneration should also provide savings in the life cycle costs of existing aircraft. The cost benefits realized through improved reliability, maintainability, and reduced spares will have a significant impact on future expenditures. In addition, initial storage of aircraft will provide a large number of additional spare components, with a corresponding decrease in the purchase requirements for replacement spares.

#### Attrition Fillers

The aircraft stored as a part of any regeneration plan provide our country with a ready source of attrition-filler aircraft in case of war. If aircraft are attritted during a conflict, the stored aircraft could be regenerated in a similar configuration to replace the lost capability in significantly less time, and at a much lower cost, than purchasing replacement aircraft. Many of the structural components found on stored aircraft are not usually available in supply channels. These structural parts could be quickly removed in order to repair battle damaged aircraft.

"Even in a national emergency, some aircraft spares might not be available for 2 years or more because of long procurement and manufacturing lead times, caused primarily by a relatively small defense industrial base already burdened with supporting old and new aircraft technologies."<sup>27</sup> The logistics support of DESERT SHIELD caused AMARC to remove 875

parts from B-52, F-111, and C-130 aircraft in storage in order to meet critical mission requirements.<sup>28</sup>

#### Benefits From New Weapon Systems

It is vital to establish links between new aircraft technology and requirements of existing weapon systems. The Air Force Systems Command (AFSC) has been formally tasked to "ensure that laboratory efforts consider technology insertion to overcome logistics support needs for fielded systems that are identified in weapon system master plans."<sup>29</sup> Technology insertion can also protect and enhance the production rates in new aircraft by allowing the contractor and the Air Force to take advantage of economies of scale. This will help drive down the cost-per-unit, keep production lines open, and allow for test and evaluation on existing aircraft prior to committing unknown technologies. In addition, the SPM must prioritize the requirements, along with MAJCOM coordination, to the appropriate laboratories in order to maximize the benefits of regeneration. The consolidation of AFSC and AFLC scheduled for 1992 will facilitate this process. Also, we should examine the systems developed and procured by other services, classified military programs, commercial products, and programs developed by other countries. As an example, the improvements of F-16 engines being developed by the Israelis may yield significant benefits to our Air Force.

A thorough study of technology insertion into existing Air Force weapons systems was accomplished by Mr. Roger Ashley in 1990. His conclusion was that "improving technol-

ogy insertion in existing weapon systems can only be done if AFLC System Program Managers make it a personal priority to ensure that technology insertion is accomplished on the weapon system that they manage."<sup>30</sup>

#### Test Vehicles

Often new weapons systems, replacement components, TRAP (tanks, racks, adapters, and pylons), and weapons require an aircraft in order to provide testing and validation. Stored aircraft provide a ready source for this purpose, and such test vehicles can be dedicated for an indefinite time without impacting mission readiness of the current fleet.

#### Weapon System Master Plan

"Building up without a strategy is foolish; building down without one could be disastrous."<sup>31</sup> The Weapon System Master Plan (WSMP) is the key to success for regeneration. It is a plan that has been developed by AFLC, in conjunction with the MAJCOMs, theater commanders, and the Air Staff that encompasses all aspects of each weapon system.<sup>32</sup> "It will serve as a road map and tool for integrating and scheduling future modifications."<sup>33</sup> A technology-insertion program is a key part of any weapon system master plan, whether or not regeneration is considered.<sup>34</sup> Good planning and close coordination for retrofit items are essential so that production lines will not be inadvertently terminated and so that we can get the best overall unit price.<sup>35</sup>

A Regeneration Annex should be a part of the WSMP. It must be a phased plan to procure or obtain missing parts on



aircraft targeted for regeneration and to insert new parts and systems. The key is to use technology and capability improvements wherever possible. In addition, the SPM must identify key candidates for technology enhancements and research and development efforts by the Air Force Laboratories. These can be developed independently or in conjunction with systems being procured or designed for new weapon systems. Combining AFLC and AFSC should enhance this program because it will reduce the levels of bureaucracy.

The Air Staff must evaluate the trade-offs between different weapon systems to ensure that the Air Force has a full range of capabilities to meet our needs and that we exploit our advantages. A Mission Capability Master Plan should be developed that will include the appropriate aspects of each WSMP and ensure that the Air Force retains the capability to perform all assigned missions

### Conclusion

Those responsible for equipping the Air Force face a series of difficult decisions. They must carefully balance the capabilities needed against cost and operational flexibility, all the while maintaining the overall flexibility of the entire force. In making these difficult decisions, at least four other factors are of critical importance: (1) capabilities and numbers, (2) vulnerabilities, (3) logistics, and (4) interoperability.<sup>36</sup>

Regeneration is not the ultimate solution to the multitude of challenges that will face the force structure of the Air Force as we head into the twenty-first century. However, The major advantage of regeneration is that it can allow improvements in technology to have the maximum effect on our

existing fleet of aging aircraft. It has the immediate effect of providing critical attrition fillers. It will allow our current fleet to be more capable, more reliable, more efficient, less costly, more lethal, and more cost effective. It has the additional benefit of providing insurance against the potential problems that can occur in the development and procurement of new weapon systems. It may also provide us with the most capable force, at the most reasonable cost. The techniques and process of regeneration are proven and in place. As we determine the needs of our Air Force for the next century and develop the master plan for our weapon systems, we must take into account the great advantages that regeneration can offer.

# Footnotes

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- 2 Regeneration is defined by the Random House Dictionary of the English Language (Random House, New York, 1969) p. 1110, as "to revive or produce anew; bring into existence again; to re-create, reconstitute, or make over, especially in a better form or condition."
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1989, p. 5.
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- 32 AFPC LOC/ARR, Weapon System Master Planning Guide,  
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tion Process, June 1990, p. 9.
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and Management, AFLCR 57-21, 25 November 1989, p. 9.
- 36 Basic Aerospace Doctrine of the United States Air Force,  
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